Software development for sustainable design in Vietnam: Ecosystem - An approach

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Abstract. The needs for accurate energy consumption estimation in different design alternatives are essential for all projects. The demands to achieve sustainable design drive not only the efforts of a large number of researchers and organizations all over the world but also for designers in Vietnam, especially for building design in Vietnam, whereas the green constructions are growing rapidly. The developed software in the first stage helps the designers to quickly calculate and select the alternatives for green building design. This paper is carried out under the collaboration project between Van Lang University (VLU, Vietnam) and Carnegie Mellon University (CMU, USA) to develop a software for sustainable design, which focuses on energy consumption optimization. This software is the first project towards the full software development life cycle for green design in Vietnam.

1. Background of the study

Traditionally, most of the building design in particular and construction projects in general just focus on the functions such as accommodation, utilization purposes. However, the efficient, effective and optimal design for energy consumption or environmentally friendly designs were not taken into account due to the limit of available technologies. For the last few decades, the world is facing fierce problems, especially climate change, which forces the world's governments, authorities and designers to take other approaches to achieve sustainable design. According to McKinsey studies recently, there are many reasons causing such issues:

- **Urbanization**: Over 50% of the world's population now live in cities and this trend will only continue. McKinsey estimates for the next 10 years, two third of the world population will live in cities or megacities. China and India alone will see an additional 500 million citizens move to their cities.
- **The availability of sacred natural resources** has disappeared. Energy and water in particular are major components in the cost of operations for corporations and municipal governments. So, investors, consumers, and communities all pay attention to obtain more efficient building constructions over their lifecycle.
- **Today's marketplace is intensely competitive**. The rapid changing of business environment requests the owners and AEC designers, consultants to achieve high efficiency to deliver projects faster with less environmental impact.

- **AEC projects are getting more complex.** With increasing requirements for sustainability or collaboration, projects are getting more and more complicated. You now need to coordinate and communicate design, materials, schedules, budgets, compliance, across a dispersed team of stakeholders.
- **There is a booming of new technology** – high speed, high computing capacity lead to fierce competitions between service providers.

For all these reasons, the demand for software development which can help the designers to trade - offs the alternative designs via energy consumption estimation using BIM technology is introduced and developed in the collaboration project between VLU and CMU in the software engineering field.

2. BIM background and prevailing trends

2.1. Worldwide

The rapid development of computer science recently and the applications of information technology on construction lead the trends that are driving change and opportunities in the Architecture – Engineering – Construction (AEC) industry. A component of the changes in technology we are witness to includes global trends in adoption of building information modeling (BIM) technologies.

According to Autodesk, the world No.1 in BIM technology, **BIM** originated as a term to describe a technology, but the term has evolved as industry has begun to understand the integrated nature of BIM. Today we describe BIM as a process, one that is model-centric and enabled by technology. BIM is not a product you can purchase or download, but is a methodology that is supported by a technology toolkit that helps business drive clarity.

Figure 1. Sustainable definition (Adapted from Autodesk documents)

2.2. In Vietnam

The objective of achieving sustainable design, high performance construction facilities, low environmental impact are critical for all parties.

In Vietnam, decision No. 432/QD-TTg of the Prime Minister: To approve the Strategy for Sustainable Development Vietnam during the period 2011 to 2020. Vietnam BIM steering committee is responsible for BIM implementation in Vietnam though the results are still limited.

3. Ecosystem Software Development

3.1. Software development goals

The project goals are stated in the following:

- Develop the solution for Sustainable Design Calculation Intensive system.
- Develop and implement the software architecture which can adopt sustainable software development.

- Develop a framework that helps the other teams develop later to handle the scalability within the software development processes.
- Modify Heat Load & Thermal Equipment Design to fit with the architecture.
- Development Refrigeration Cycle & Automatic Drawing Generation.
- Integrate 4 modules above into the Cooling System to prove the software architecture that can handle many modules, much system to calculate the Energy.
- Develop the project within schedule and budget.
- Create the software development framework which is guided by SEI-CMU that ensures the software quality, also the sustainable software development.

3.2. Software requirements

The requirements for Ecosystem software development focus on the analysis and calculation in design phase:

- The analysis and calculation should be defined in the strong disciplines and principles.
- Allowing perform analysis of each thermal equipment individually, and then can be integrated these item calculation results to the whole system.
- The analysis and calculation should be optimal by the mathematics, algorithm and automatically, that reduce the effort for who performs the analysis.
- Reports should be generated automatically in the common standard form for many items and systems.
- Can have ability to integrate with the other vendors, such as Autodesk Revit, IES.
- Support analysis and calculation in design phase of construction projects, especially in Green Building Project.
- Meet the various rating systems, especially Vietnam standards.

3.3. Software development life cycle

For software development, the software engineering disciplines and principles must be strictly followed to achieve the quality product. In Ecosystem software development, the software development model is shown in figure 2 and 3.

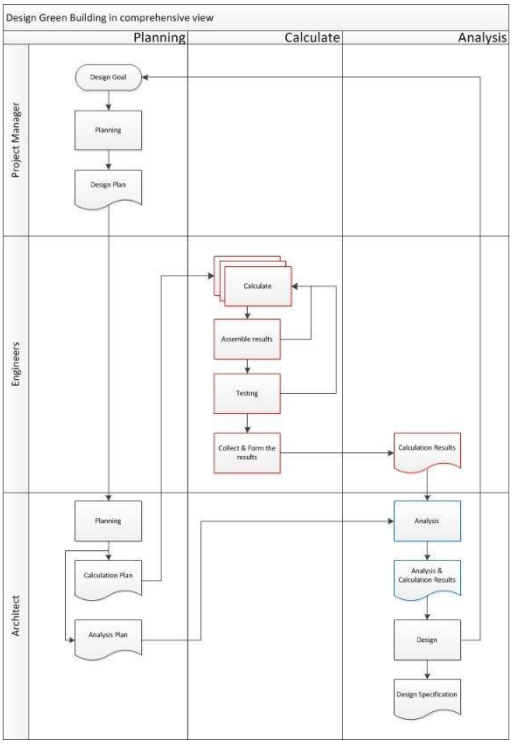

Figure 2. Ecosystem software in comprehensive view

There are also many software development models but for this project the V model is selected for the development.

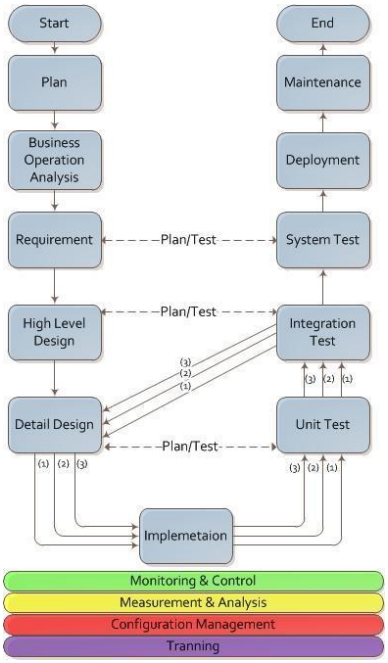

Figure 3. Ecosystem software – The V Model

3.4. Software development processes

Ecosystem software development life cycle consists of three main processes: Development Process – Management process and Teamwork process. All these processes are linked together in figure 4.

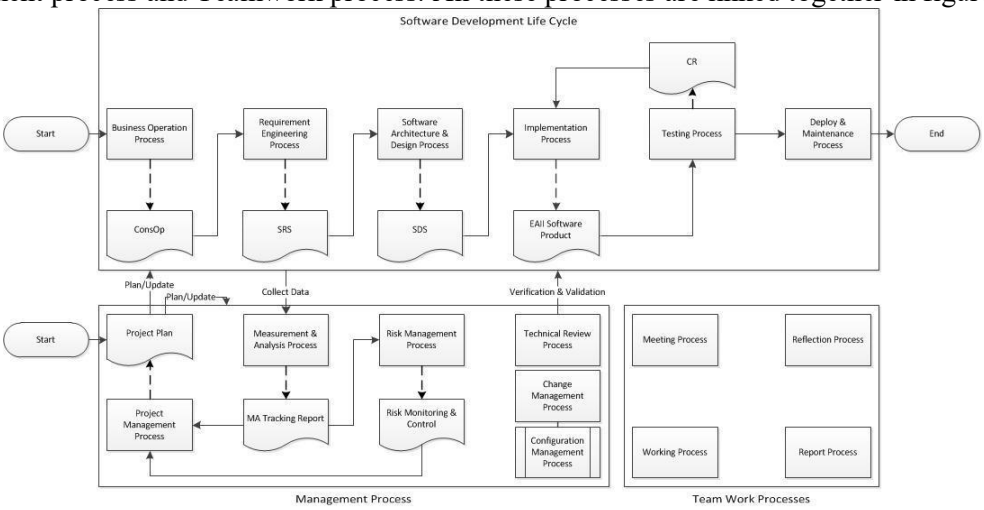

Figure 4. Ecosystem software – Development life cycle processes

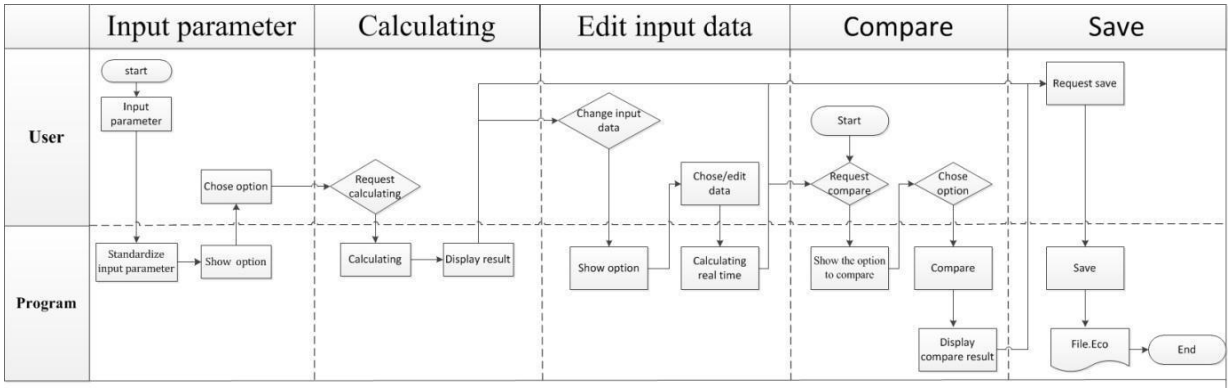

Figure 5. Ecosystem software – A typical calculation diagram

3.5. Software development deliverables

Table 1. Ecosystem software deliverables

Deliverable	Description
Process Description	Each process has been documented for description in detail.
Concept of Operation (ConsOp)	The document that describes ES Team's solution, includes the real problem of the customer, limited current situation and our team suggestion.
Software Requirement Specification (SRS)	The document that describes the software requirement for the ES development team.
Software Architecture Driver Specification (SAD)	The document that describes the software architecture driver which analyzed and filtered from SRS.
Software Architecture Specification (SAS)	The document that describes the architecture of ES.

Software Design Specification (SDS)	The document that describes the design of ES
Project Plan	The project plan of ES.
Project charter	The charter of ES.
Software Product	The stand-alone and installable application of ES.
User Guide & Installation Guide	The guide including with ES.
Presentation Slide	The presentation for capstone report & product promotion.
Measurement Plan (MP), Analysis Plan (AP), Measurement Report (MR).	The suite of documents on the Measurement & Analysis Program of ES.
Risk Management Plan (RMP), Risk Tracking and Report (RTR).	The suit of documents on Risk Management.
Testing Suit	Including Test Plan (STP), Test Cases (STCs) and Test Report (STR).

4. Ecosystem Software

The below pictures show few results from Refrigeration Cycle Calculation Module.

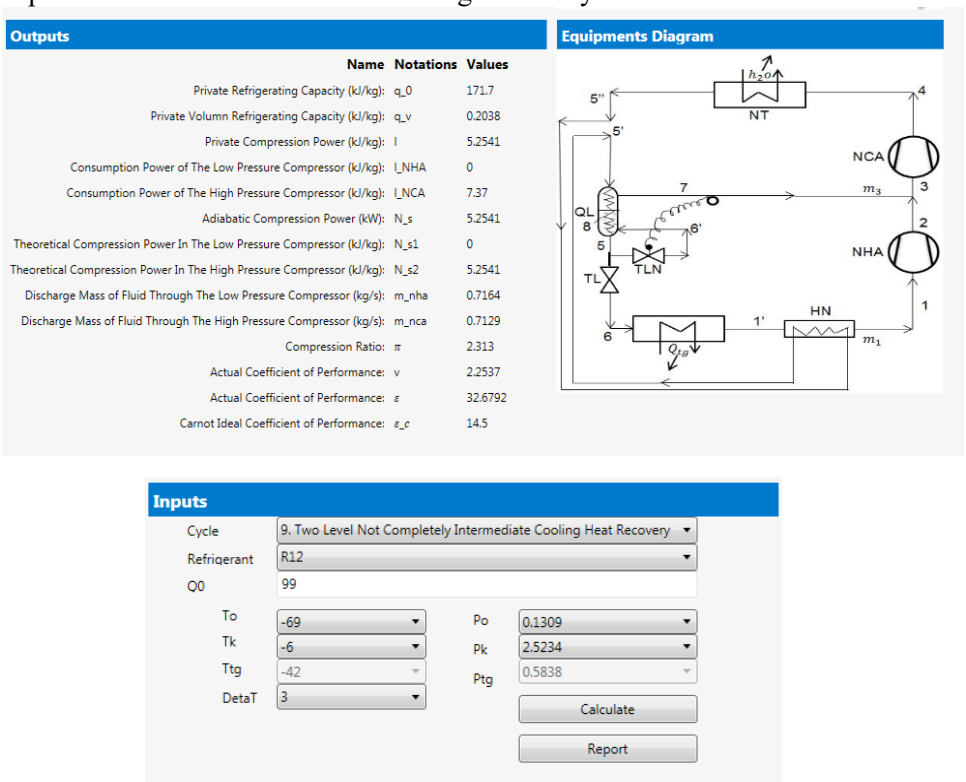

Figure 6. Ecosystem software – Refrigeration Cycle Calculation

5. Conclusion

This is the first step towards the full software development life cycle with full illustrated processes from the requirement phase to testing phase. Especially, this software development has both practical meaning in the academic environment and best practices for specific domain software development. The software helps the designers to perform the calculations rapidly in comparison with the traditional, time consuming methods.

The author will take the next investigation for integrated solution in sustainable solution optimization and automation while eliminating manual, time consuming calculation.

Acknowledgement

The author would like to express his deep gratitude and thanks to Van Lang University for financial support for this project, VLU's students and lecturers for the advices, positive contributions. Special thanks go to Institute for Software Research's professors and staff, Carnegie Mellon University, USA for their invaluable help.

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